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Collective Jahn-Teller Distortions in $La_{7/8}Sr_{1/8}MnO_3$ at High Magnetic Fields

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Introduction: The investigation of the doped maganites is still one of the central issues of modern solid state physics. The rich physics of these materials originate from the pronounced interplay between the structural, magnetic, electronic and orbital degrees of freedom. In particular, these couplings result in a strong field dependence of the different ordering phenomena in $La_{7/8}Sr_{1/8}MnO_3$. In this context we already reported the stabilization of the charge ordered state in magnetic fields, which is clearly not understandable in terms of a naive double exchange picture [1,2]. Moreover, we could show that the irradiation effect is also strongly field dependent [2]. In this abstract we are dealing with the results of our second experiment where we have focused on the phase transition into the collective Jahn-Teller distorted (JTD) phase at higher temperatures.

Methods and Materials: We have studied the influence of magnetic fields on the collective JTD phase in $La_{7/8}Sr_{1/8}MnO_3$ using resonant x-ray scattering. Therefore, the single crystalline sample has been mounted inside a liquid helium cryostat equipped with a superconducting magnet.

Results: As demonstrated in the right part of Fig.1 the lattice parameters display a pronounced field dependence in the JTD phase, signaling the suppression of the collective JTD phase, i.e. the orbital ordering. This suppression is also shown by the considerable reduction of the resonant intensity with increasing field. Furthermore, it is possible to drive the phase transition from the orbital ordered to the orbitally disordered state by applying external magnetic fields (see left part of Fig. 1). In contrast to the charge ordered phase, *the collective JTD phase is destabilized in external magnetic fields*. This is consistent with the bare double exchange picture where the application of an magnetic field increases the charge carrier mobility and thus suppresses the collective distortions. *Since charge order and JTD compete with each other, the anomalous stabilization of the charge ordered state might be due to the destabilization of the JTD state.*
Another interesting observation was made concerning the temperature dependence of the integrated intensity of the (300) reflection: Our measurements indicate an irreversible behavior of the intensity around T_{JT} in high external fields, that is the zero field cooled warming curve differs from the following field cooling curve (left part of Fig.1). Indications for such an irreversibility are also found in our dilatometric measurements.

Conclusions: The collective JTD phase has been studied using resonant x-ray scattering in magnetic fields. With increasing magnetic field strength the collective JTD are strongly destabilized, which might explain the anomalous stabilization of the charge ordered state. Furthermore, our measurements suggest a difference between the field cooled and the zero field cooled state below T_{JT} .

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References:

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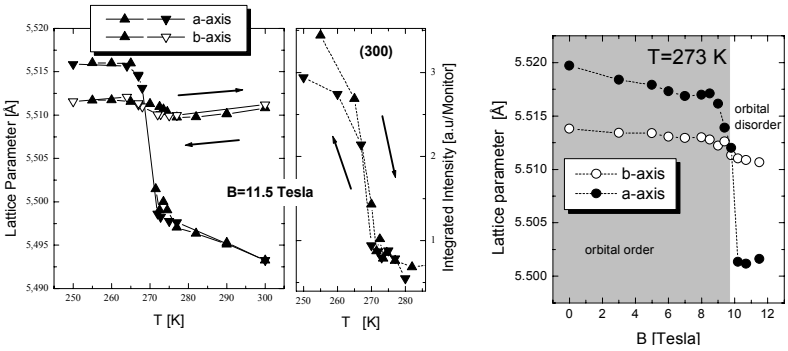

Figure 1: *Left:* Temperature dependence of the lattice parameters and the integrated intensity of the resonant (300) reflection in a magnetic field of 11.5 Tesla. The integrated intensity seems to show an irreversibility (not observed for the lattice parameters within the experimental resolution). *Right:* Field induced phase transition from the orbital ordered to the orbital disordered state